MYCOTAXON

ISSN (print) 0093-4666 (online) 2154-8889 Mycotaxon, Ltd. ©2020

April–June 2020—Volume 135, pp. 345–354
https://doi.org/10.5248/135.345

New records of graphidoid and thelotremoid lichens from India

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Abstract—*Chapsa cinchonarum*, *C. farinosa*, *Diorygma sticticum*, *Fissurina albocinerea*, *Graphis bungartzii*, *G. discarpa*, *G. nigririmis*, *Ocellularia alba*, *Phaeographis pseudostromatica*, *Sarcographa verrucosa*, and *Thelotrema crassisporum* are described and illustrated as new records for India.

Key words —lichenized fungi, *Graphidaceae*, *Ostropales*, taxonomy

Introduction

Graphidaceae (sensu Rivas Plata & al. 2012) is the largest family of tropical crustose lichens with about 2700 accepted species world-wide (Lücking & al. 2014, 2017a,b); it includes the previously separated, well-known families *Graphidaceae* and *Thelotremataceae*. Kraichak & al. (2018) resurrected *Diploschistaceae* and *Thelotremataceae* which were previously synonymized under *Graphidaceae* and accepted the family *Fissurinaceae* proposed by Hodkinson (2012).

Here we use *Graphidaceae* sensu Rivas Plata & al. (2012). The family is characterized by: crustose thallus with a trentepohlioid photobiont; lirellate to rounded ascomata; carbonized or non-carbonized proper exciple; inspersed or non-inspersed hymenium; presence or absence of periphysoids; hyaline to brown, transversely septate to muriform ascospores often with amyloid septa, lens-shaped to rectangular lumina, and the presence or absence of lichen compounds. A total of 570 graphidoid and 131 thelotremoid species were known from India (Singh & Sinha 2010, Sinha & al. 2018). During the study of *Graphidaceae* specimens available in the herbarium of the National Botanical Research Institute, Lucknow, India (LWG), eleven more species were identified as new to India. They are described below.

Material & methods

Morphological observations were made using the Leica S8APO stereomicroscope with image analyzer software. Thin, hand-cut sections of the thalli and ascomata were mounted in water, lactophenol cotton blue, 10% KOH, or Lugol's iodine solution and observed under the Leica DM2500 compound microscope. All anatomical measurements were taken in water mounts. Secondary metabolites were identified by thin layer chromatography (TLC) following Orange & al. (2010). The examined specimens are preserved in the herbarium LWG.

New records

Chapsa cinchonarum (Fée) Frisch, Biblioth. Lichenol. 92: 95 (2006) FIG. 1A

Thallus crustose, corticolous, white to pale greenish-grey, continuous, matte to mealy or faulty, ecorticate; apothecia angular to elongated and often slightly branched, 0.5–0.8 mm long; margin jagged to lobed, slightly incurved to recurved, with a white to pale fawn, compact to felty inner surface; disc pale brown, covered by thick white felty to crystalline pruina; exciple fused, uncarbonized; hymenium hyaline, clear, 70–110 µm high, I–; ascospores 8/ascus, hyaline, fusiform, 8–14-locular, 18–35 × 4–6 µm, I–; lichen substances absent.

SPECIMEN EXAMINED: **INDIA. GOA, Cotigao Wildlife Sanctuary**, 14°57′11″N 74°09′21″E, on bark, 12 September 2017, Pallavi P. Randive GU L575 (LWG-35879).

COMMENTS—Morphologically *Chapsa cinchonarum* closely resembles *C. alborosella* (Nyl.) Frisch, which differs in having more rounded apothecia with a rim-like margin and 5–9-locular, smaller (17–22 × 4.5–5 µm) ascospores. It somewhat resembles *Astrochapsa platycarpella* (Vain.) Parnmen & al., which possesses 4–7-locular, smaller (12–16 × 3–5 µm) ascospores.

Previously known from tropical Africa and the Neotropics (Frisch & al. 2006, Rivas Plata & al. 2010).

Chapsa farinosa Lücking & Sipman, Phytotaxa 55: 37 (2012) FIG. 1B

Thallus crustose, corticolous, white-grey, distinctly farinose, ecorticate; apothecia erumpent, angular-rounded, 0.2–0.5 mm diam.; disc exposed, flesh-coloured to pale brown, white-pruinose; margin lobulate to recurved, pale brown, felty white-pruinose; exciple fused, uncarbonized; hymenium hyaline, clear, I–; ascospores 8/ascus, hyaline, fusiform-oblong, with slightly thickened septa and rectangular lumina, 8–10-locular, 20–32 × 4–6 μm, I–; lichen substances absent.

Specimens examined: **INDIA. Goa, Ta Rivana**, Quinamol, 15°09′20″N 74°06′21″E, 2 December 2016, Pallavi P. Randive GU 400, 404 (LWG-35882, 35883).

Comments—*Chapsa farinosa* is characterized by its whitish, farinose thallus lacking any traces of a cortex. *Chapsa cinchonarum* can be easily confused with *C. farinosa* but has a compact thallus with loose cortex and often elongate lirellae. Anatomically, it resembles *C. albida* (Nyl.) Lücking & Sipman but differs in the distinctly verruculose thallus with irregular cortex (Rivas Plata & al. 2010).

Previously known from Costa Rica (Sipman & al. 2012).

Diorygma sticticum Sutjar., Kalb & Lücking, Phytotaxa 18: 49 (2011) Fig. 1c

Thallus crustose, corticolous, light green, smooth to uneven, continuous, ecorticate; apothecia lirellate in dense clusters, stellately branched, erumpent, with thick, complete, white thalline margin, 1–2.5 × 0.15–0.3 mm; disc concealed to partly exposed, pale brown but thickly white-pruinose; exciple conspicuous, uncarbonised, entire, basally orange-brown, upper part hyaline; epihymenium granulose, yellow-brown; hymenium hyaline, clear, I–; ascospores 8/ascus, hyaline, fusiform, submuriform, 10–15 × 6–8 μm, I+ blue, rarely found; stictic acid present.

Specimen examined: **INDIA. Goa, Cotigao Wildlife Sanctuary**, 15°01′07″N 74°12′33″E, on bark, 15 December 2017, Pallavi P. Randive GU 193 (LWG-35880).

Comments—*Diorygma sticticum* is characterized by its small submuriform ascospores and the presence of stictic acid. *Diorygma nothofagi* (A.W. Archer) A.W. Archer and *D. poitaei* (Fée) Kalb & al. are morphologically similar but *D. nothofagi* differs by larger (18–23 μm long) ascospores and the presence of norstictic acid while *D. poitaei* is distinguished by the larger (40–65 μm long) ascospores and presence of hypostictic and hypoconstictic acids.

Previously known from Thailand (Kalb & al. 2004, Feuerstein & al. 2014).

Fissurina albocinerea (Vain.) Staiger, Biblioth. Lichenol. 85: 126 (2002) Fig. 1d

Thallus crustose, corticolous, greyish-green, smooth, glossy, corticate; apothecia lirellate, immersed to slightly raised, simple to very rarely branched, 0.4–2 mm long, straight to curved, terminally acute; disc sunken, slit-like, epruinose; exciple entire, uncarbonized, orange-brown; hymenium hyaline, clear, I−; ascospores 8/ascus, hyaline, 4-locular, 16–18 × 6–9 µm, I−; psoromic acid present.

SPECIMEN EXAMINED: **INDIA. GOA, Cotigao Wildlife Sanctuary**, 14°58′23″N 74°09′36″E, on bark, Pallavi P. Randive, GU 99, 108 (LWG-35884).

COMMENTS—*Fissurina albocinerea* belongs to the group of species having *Dumastii*-type ascomata and is clearly distinguished from the other species of this group in having small ascospores and psoromic acid in the thallus.

Previously known from the Philippines (Staiger 2002).

Graphis bungartzii A.B. Peña, Lücking, Herrera-Camp. & R. Miranda, Lichenologist 46: 71 (2014) FIG. 1E

Thallus crustose, corticolous, pale greenish-brown, smooth, continuously corticate; apothecia lirellate, flexuous, branched, erumpent with lateral thalline margin, 1–2.5 mm long, 0.1–0.3 mm wide; labia concealed, striate, black; exciple thick, laterally carbonized, 15–45 µm wide; epithecium brown, granulose; hymenium hyaline, clear, I−; ascospores 8/ascus, hyaline, ellipsoid to fusiform, 4–10-locular, 25–32 × 5–8 µm, I+ blue; norstictic and connorstictic acids present.

SPECIMENS EXAMINED: **INDIA. ASSAM, Sonitpur district**, Panigaon, Miranda, 75 m, 25 February 2013, on *Syzygium cumini* bark, R. Daimari 14-020543, 14-022465, 14-022467 (LWG); Pithakowa, 70 m, 18 March 2012, on *Bombax* sp., R. Daimari 14-022460 (LWG); New Siliguri, 118 m, 21 March 2013, R. Daimari 14-022463 (LWG); Borbhogia, 64 m, on *Lannea grandis* bark, 26 March 2013, R. Daimari 14-022464 (LWG); Ratanjuli, on *Artocarpus heterophyllus* bark, 21 March 2013, R. Daimari 14-020556 (LWG).

COMMENTS—*Graphis bungartzii* differs from *G. elegans* (Sm.) Ach. by the presence of erumpent lirellae with lateral thalline margin and the smaller ascospores. *Graphis filiformis* Adaw. & Makhija is also similar to *G. bungartzii* but differs in having longer, irregularly to radiately branched lirellae with entire labia and in lacking connorstictic acid.

Previously known from Mexico (Barcenas-Peña & al. 2014).

Graphis discarpa A.W. Archer, Mycotaxon 89: 325 (2004) FIG. 1F

Thallus crustose, corticolous, pale olive-green, dull, corticate; apothecia lirellate, numerous, scattered, immersed, simple, straight, curved or sinuous, rarely branched, concealed, 1–3 × 0.15–0.3 mm, visible as a thin black line with white margins, separated from the thallus; exciple entire, completely carbonized; hymenium hyaline, clear, I−; ascospores 8/ascus, hyaline, narrowly ellipsoid to fusiform, 8–11-locular, 32–40 × 8–10 µm, I+ blue; stictic acid present.

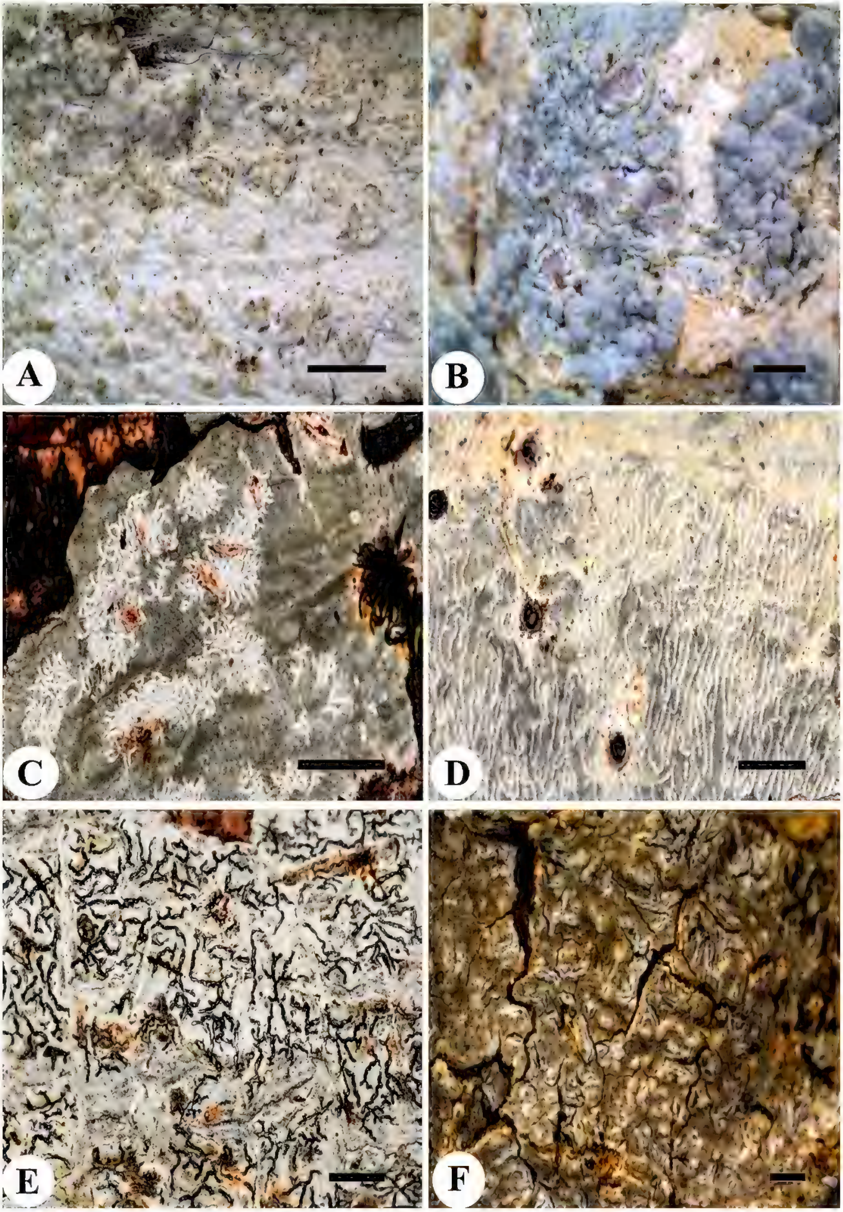

Fig. 1. A. ***Chapsa cinchonarum*** (LWG-35879); B. ***Chapsa farinosa*** (LWG-35882); C. ***Diorygma sticticum*** (LWG-35880); D. ***Fissurina albocinerea*** (LWG-35884); E. ***Graphis bungartzii*** (LWG-14-020543); F. ***Graphis discarpa*** (LWG-14-024670). Scale bars = 1 mm.

Specimen examined: **INDIA. West Bengal, West Medinipur district**, Mohunpur, IISER-Kolkata campus, January 2014, T. Hembram, S. Nayaka & S. Asthana 14-024670 (LWG).

Comments—*Graphis discarpa* is closely related to *G. glaucescens* Fée with respect to external morphology but distinguished by its entire to striate exciple, ecorticate, glaucous grey thallus without lichen substances. *Graphis immersella* Müll. Arg., which is also morphologically similar, can be distinguished from *G. discarpa* in having stictic acid and a laterally carbonized exciple.

Previously known from Papua New Guinea (Archer 2004).

Graphis nigririmis (Nyl.) Müll. Arg., Bull. Herb. Boissier 3: 320 (1895) Fig. 2a

Thallus crustose, corticolous, pale olive green, thin, smooth and shiny; apothecia lirellate, inconspicuous, immersed, visible only as a thin black or dark brown line, sometimes becoming conspicuous as black immersed lirellae, simple to branched, 1–3 mm long, 0.05–0.1 mm wide; disc concealed or slightly open; exciple entire, pale orange-brown, weakly apically carbonised; hymenium, hyaline, clear, I–; ascospores 8/ascus, ellipsoid to fusiform, 4–7-locular, 18–25 × 8–16 µm, I+ blue; lichen substances absent.

Specimen examined: **INDIA. Tamil Nadu, Namakkal district**, Kolli Hills, 800 m, on bark, 20 March 2016, S. Nayaka & party 16-029294 (LWG).

Comments—*Graphis nigririmis* resembles *G. glaucescens,* which is distinguished by the larger ascospores and the corticated, farinose thallus.

Previously known from Australia (Archer 2009).

Ocellularia alba (Fée) Müll. Arg., Mém. Soc. Phys. Genève 29(8): 6 (1887) Fig. 2b

Thallus crustose, corticolous, white-grey to pale olive, smooth to uneven, with prosoplectenchymatous cortex; apothecia erumpent, rounded, 0.2–0.3 mm diam., ecolumellate; disc exposed, pale brown, white-pruinose; margin white pruinose; pores usually small, occasionally broad, to c. 0.2 mm wide, mostly ±rounded to somewhat irregular; exciple usually thin, hyaline internally, pale yellowish to yellowish brown marginally, fused; hymenium hyaline, clear; ascospores 8/ascus, hyaline, fusiform, with slightly thickened septa and rectangular lumina, 4–6-locular, 18–24 × 4–8 µm, I–; lichen substances absent.

Specimen examined: **INDIA. Goa, Cotigao Wildlife Sanctuary**, 14°57′11″N 74°09′21″E, on bark, 15 January 2018, Pallavi P. Randive GU 676 (LWG-35881).

Comments—*Ocellularia alba* is morphologically resembles *O. papillata* (Leight.) Zahlbr. and differs in the dark brown exciple and columella.

Previously known from Australia, Brazil, the Philippines (Hale 1978).

Phaeographis pseudostromatica Seavey & J. Seavey, Bull. Florida Mus. Nat. Hist. 53: 228 (2017) FIG. 2C

Thallus crustose, corticolous, brownish-grey, shiny, continuous; apothecia lirellate, thin, brownish-black, immersed to erumpent, partly branched, 0.2–1 mm long, arranged in broad confluent pseudostromatic areas; disc partly open, brownish-black, epruinose; exciple brown, apically slightly thickened, 20–25 µm wide; epihymenium brown; hymenium hyaline, inspersed; ascospores 8/ascus, brown, fusiform, submuriform, 4–6 × 1–2-locular, 22–30 × 7–10 µm; norstictic acid present.

SPECIMEN EXAMINED: **INDIA. ASSAM, Sonitpur district**, Arimora, on Korsun bark, 54 m, 13 March 2012, R. Daimari 14-022470 (LWG).

COMMENTS—*Phaeographis pseudostromatica* is morphologically similar to *P. quadrifera* (Nyl.) Staiger but differs by its lirellae arrangement in pseudostromal tissue. It is also similar to *P. nylanderi* (Vain.) Zahlbr. which shares the inspersed hymenia and the presence of norstictic acid but differs in the transversely septate ascospores and the absence of pseudostromata.

Previously known from Florida (Seavey & al. 2017).

Sarcographa verrucosa (Vain.) Zahlbr., Cat. Lich. Univ. 2: 467 (1924) FIG. 2D

Thallus crustose, corticolous, olive-brown to yellow-brown, verruculose, corticated; apothecia lirellate, grouped together in white stromata at the thallus level or sunken; thalline margin at edge of the stroma or with extended lirellae; stromata irregularly ovoid, flattened; black, with crowded, open, not confluent or branched, sub-circular, 0.2–0.4 mm long lirellae; disc black, white-pruinose; exciple thin, carbonized or dark brown, 10–15 µm; epihymenium grey to brownish, granular; hymenium hyaline, inspersed; ascospores 8/ascus, brown, 4–6-locular, 19–26 × 6–8 µm; stictic acid present.

SPECIMEN EXAMINED: **INDIA. ASSAM, Sonitpur district**, Choibari, on *Chukrasia tabularis* bark, 81 m, 25 February 2013, R. Daimari 14-022477 (LWG).

COMMENTS—*Sarcographa verrucosa* differs from all other *Sarcographa* species by its olive brown, verruculose thallus, highly inspersed hymenium, submuriform ascospores, and stictic acid chemistry. In having white stroma, white pruinose disc and muriform, brown ascospores, *Sarcographa subtorquescens* (Nyl.) Zahlbr. resembles *S. verrucosa* but differs in having a clear hymenium and larger (2–27 × 9–11 µm) ascospores. *Sarcographa labyrinthica* (Ach.) Müll. Arg. and *S. glyphiza* (Nyl.) Kr.P. Singh & G.P. Sinha are also morphologically very similar, but *S. labyrinthica* differs in having transversely septate, 4–6-locular ascospores and a K+ reddish thallus, while

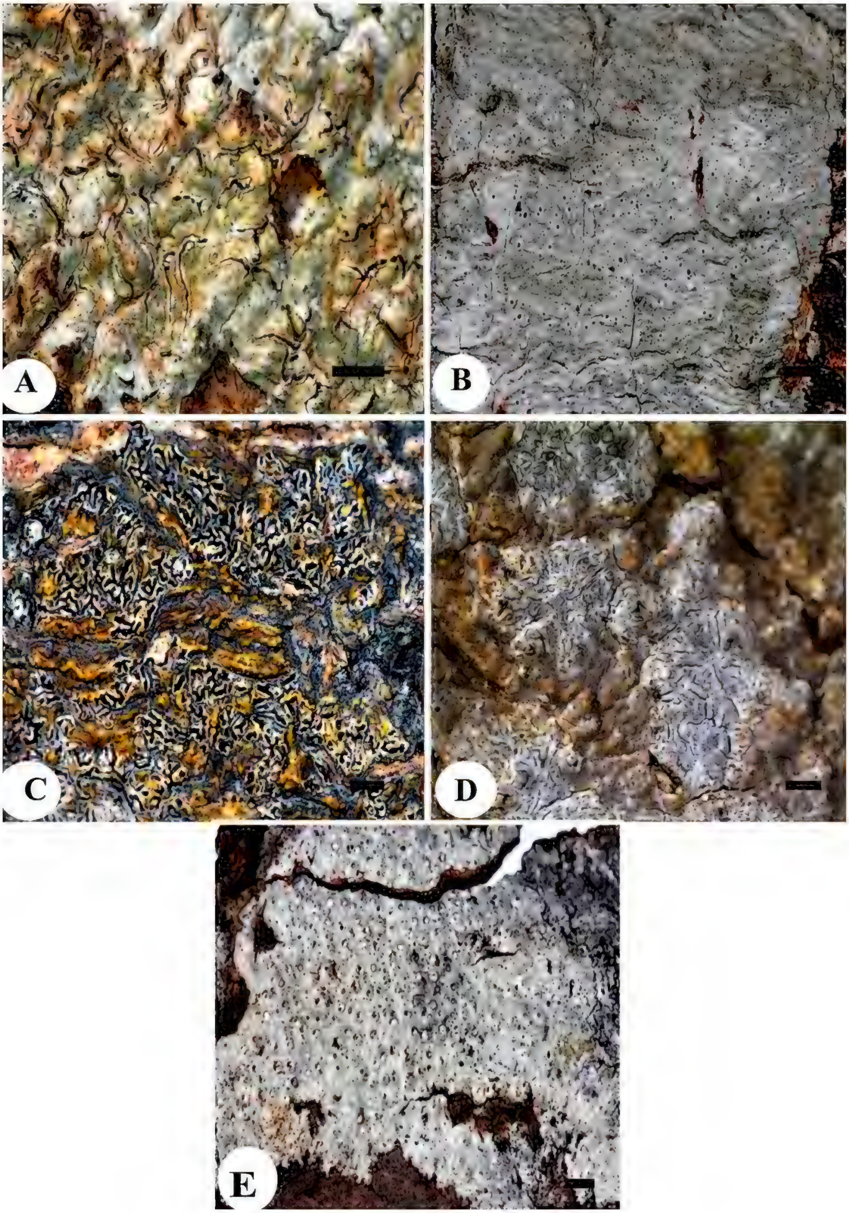

FIG. 2. A. ***Graphis nigririmis*** (LWG-16-029294); B. ***Ocellularia alba*** (LWG-35881); C. ***Phaeographis pseudostromatica*** (LWG-14-022470); D. ***Sarcographa verrucosa*** (LWG-14-022477); E. ***Thelotrema crassisporum*** (LWG-35878). Scale bars = 1 mm.

S. glyphiza has larger (25–31 × 9–13 µm) ascospores and a K+ red thallus with stictic and constictic acid.

Previously known from Australia, Indonesia, and the Philippines (Archer 2009).

Thelotrema crassisporum Mangold, Flora of Australia 57: 657 (2009) FIG. 2E

Thallus crustose, corticolous, pale yellowish grey to pale greenish grey, smooth, continuous, ecorticate; apothecia c. 0.5-0.6 mm diam., ±rounded, solitary to slightly marginally fused, emergent, mostly hemispherical; disc pale greyish, slightly pruinose, invisible from above; pores c. 0.1 mm diam., irregular; exciple completely free, thin, hyaline internally, yellowish brown marginally, apically dark brown; hymenium hyaline, clear; ascospores 8/ascus, hyaline, submuriform, subglobose to ellipsoidal, with ±rounded ends, 4–7 × 1–2-locular, 14–20 × 8–10 µm, I–; constictic and stictic acids present.

SPECIMEN EXAMINED: **INDIA. GOA, Cotigao Wildlife Sanctuary**, 14°57′11″N 74°09′21″E, on bark, 06 February 2016, Pallavi P. Randive, GU 581 (LWG-35878).

COMMENTS—*Thelotrema crassisporum* is similar to *T. myriocarpum* Fée, which is distinguished by a shiny, smooth, corticated, non-fissured thallus and larger (≤40 µm long) ascospores.

Previously known from Australia (Mangold 2009).

Acknowledgments

We are thankful to the Director, CSIR-NBRI, Lucknow, for providing the facilities to carry out the research and to Dr D.K. Upreti (National Botanical Research Institute, Lucknow) for encouragement. We thank Drs. T.A.M. Jagadeesh Ram (Botanical Survey of India, ANRC, Port Blair) and Harrie Sipman (Botanical Museum, Berlin) for reviewing the manuscript. Authors PR and MKJ thank Vice Chancellor, Goa University, Goa for facilities and the Forest Department of Goa for permission to survey Cotigao Wildlife Sanctuary. PR is also thankful to DST for financial assistance under the Women Scientist Scheme (SR/WOS-A/LS-354/2016). Author RD is thankful to Dr. Raza R. Hoque, Tezpur University for his guidance. One of the authors (SJ) is thankful to SERB for financial assistance under the N-PDF scheme (PDF/2016/002054).

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